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RESEARCH PAPER

Effect of heavy metals on kidney function among petroleum industry workers in the Kurdistan region

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A B S T R A C T:
Heavy metals have severely polluted the environment. The kidney is usually the first organ to be impacted by heavy metal exposure due to its potential to accumulate and detoxify metal ions. Some heavy metals and kidney function of oil field employees in Kurdistan Region of Iraq were studied in this research. This study was based on primary data collected throughout recent five years. Forty adult males who participated in this region were divided into two main groups; the former consisted of twenty individuals who had been exposed to Occupational Chemicals for more than five years in the oilfield area, and the other included twenty individuals who had not been exposed and used as a control group. Cobas C311 instrument was used as a biochemical analyzer to investigate some biochemical parameters in the serum level, and inductively coupled plasma was performed to estimate some heavy metals in whole blood. The results show a highly significant difference in some heavy metals such as (Silver (Ag), Iron (Fe), Cadmium (Cd), Manganese (Mn) and Vanadium (V)) which increased in the exposed group compared to the group that served as a control. However, there was no statistically significant difference in the levels of the other heavy metals (Mercury (Hg), Lead (Pb), and Zinc (Zn)) between the two groups described. Furthermore, the level of kidney function parameters, including creatinine and blood urea, was revealed non-significantly higher than in the exposed group compared to the control group, except for uric acid, which significantly rose.

KEY WORDS: Oilfield worker, Pollution, Heavy metals, petrochemicals, Kidney function.DOI:
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1. INTRODUCTION:

Pollution is the most severe of all the concerns that impact the environment and provides a significant health risk to humans (Sojinu and Ejeromedoghene, 2019). So, crude oil products significantly contribute to environmental Pollution in oil-producing regions (Nwadibe et al., 2020). Heavy metals are among the most dangerous of the forms of ecological pollutants (Amjadian et al., 2016). Heavy metals are often defined as metals and metalloids with a density of more than 5 g/cm^3 (Kan et al., 2021). Certain heavy metals such as cobalt and manganese are necessary for human health in low physiological and environmental concentrations.

Nevertheless, others (e.g. lead [Pb], cadmium [Cd], arsenic [As], mercury [Hg]) are poisonous and have serious adverse effects on human health problem, even in trace amounts (Jalili et al., 2021). Heavy metals in high doses that cause food poisoning may also reach and deposit in the human body. Heavy metal exposure at levels above the regulatory limit causes significant human problems such as functional organ damage, abnormal development and growth, nervous system damage and cancer (Sall et al., 2020). Consequently, in the last fifty years, understanding the harmful effects of heavy metals on the human body has become more relevant due to vast quantities of these items being deposited in the environment as industrial waste and not decomposing for a long time (Anto et al., 2020).

Heavy metal poisoning affects the kidney, and the severity of renal damage caused by heavy metals varies based on the route, dose, nature and

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the length of exposure (Humudat and Al-Naseri, 2020). Epidemiological studies have shown a link between environmental exposure and the progression of this disease (Fisher and Gupta, 2021). Environmental nephron-toxins, some types of Chronic kidney disease (CKD), have been related to factors including heavy metals, mycotoxins made by fungi in stored foods, air pollutants, and pesticides (Ferraro et al., 2010). Moreover, several findings have shown a significant correlation between the progression of chronic kidney disease and exposure to heavy metals, including Lead, Cadmium and Mercury (Farkhondeh et al., 2021).

The economy of Kurdistan Region of Iraq (KRI) is mostly depend on around oil and natural gas production and processing. Due to the lack of observations on the impacts of heavy metals on kidneys in the crude oilfield employees, the current study evaluated the effect of some heavy metals on functioning kidneys in crude oil field employees who had worked for about five years in various regions of Kurdistan.

2.MATERIALS AND METHODS

2.1Chemical materials

Fisher Scientific in (Dubai, United Arab Emirates) provided the nitric acid (HNO3) (67–70%), hydrogen peroxide 1 (H_2O_2) (30%), and multi-element standard solution 1 for ICP (Trace CERT®, in 5% nitric acid). De-ionized water (resistivity 18.2 Mohm cm, TOC less than 1 μg/L) was designed and made in-house using an ELGA-Veolia Lab Water type I distilled water purification mechanism (High Wycombe, UK).

2.2Blood sample collection

To detect the presence of silver (Ag), iron (Fe), cadmium (Cd), and zinc (Zn) metals as well as toxic substances manganese (Mn), mercury (Hg), lead (Pb), and vanadium (V), in the blood of oil field worker. These employees were randomly selected from four locations in Kurdistan Region in Northern Iraq, including the Taq-Taq oil field, Kawerkosg refinery, Khurmala oil field, and Banan oil rig (Figure 1). Only men operate in crude oil fields due to the nature of the work, the shifting hours, and the remoteness. All participants were between the ages of 20 and 35, had worked in the crude oil industry for at least five years, were free of any chronic diseases, and agreed to contribute to the study. All group members were examined between January and December of 2021. Six millilitres of concentrated venous blood were taken from the exposed and control groups. Blood was centrifuged for 10 minutes at 3000 rpm to isolate the serum.One milliliter of serum added into a polystyrene tube, and then 9 milliliter of nitric acid (69.5 % v/v) was added. After incubating the mixture at room temperature for ten hours, it was centrifuged at 3000 rpm (4000g) for ten minutes.

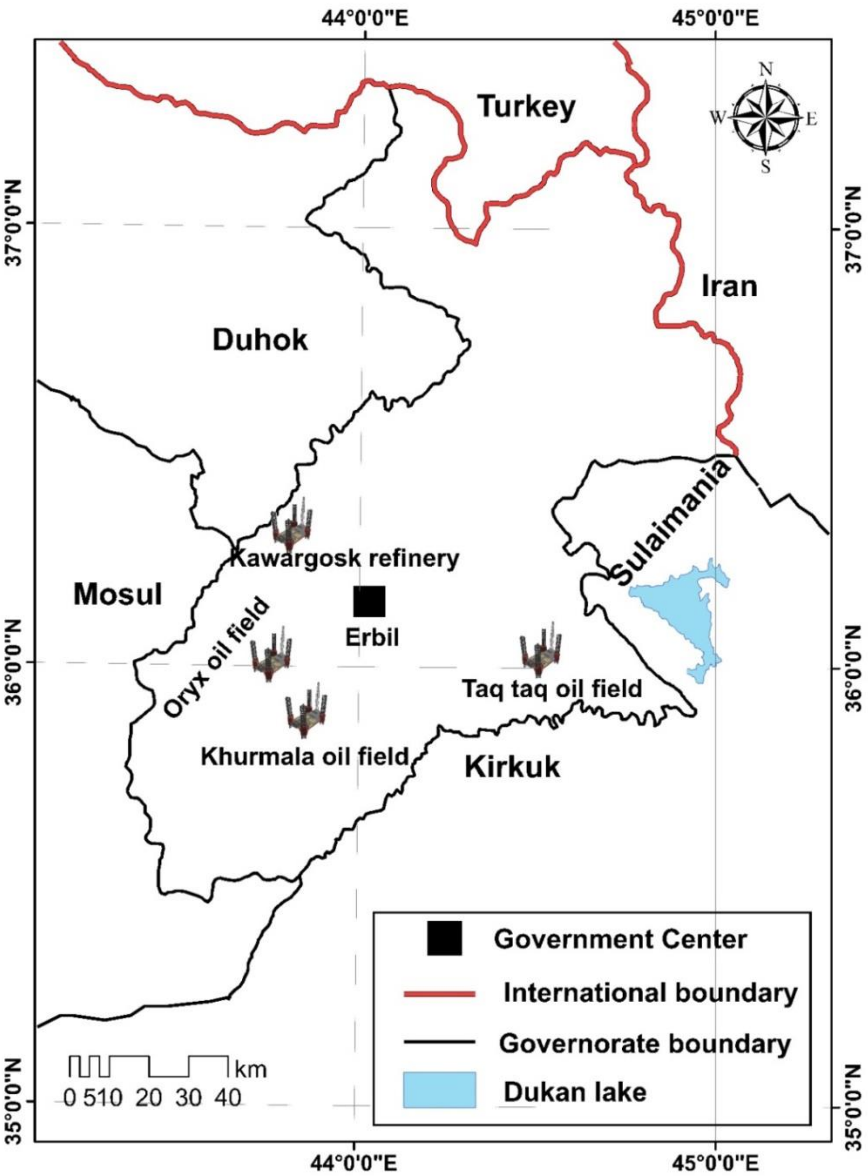

Figure 1: crude oil fields in northern Iraq's Kurdistan region.

2.3Biochemical parameters

External standard calibration were provided to quantify heavy metals by preparations about nine standard solutions from multi-element standard solutions for ICP (TraceCERT®, in 5% nitric acid). Calibration was conducted via plotting measured peak areas against the range of corresponding standard concentration. We studied each curve to linear regression. To minimize matrix effects and interferences, we prepared all standard solutions and analysed data in nitric acid (HNO3). Additionally, standard solutions of 25 (μg/L) were injected seven times to determine the limit of quantification (LOQ) and limit of detection (LOD).

The standard deviation of peak areas was divided by the slope of the calibration curve for each metal by three and ten times, respectively. Increased the standard solutions used to create the standard calibration curve to (100, 500, 1000, 5000, and 100,000) μg/L and evaluate the linearity. The samples were dissolved when their concentrations reached the linearity range. Analytical method data can be found in Table 1.

Table 1. Calibrating of heavy metals in ICP instrument.

Heavy metal	LOD (µg/L)	LOQ (µg/L)	Wavelength (nm)
Ag	0.000246	0.00082	328.07
Cd	0.0006271	0.00146	317.935
Fe	0.001638	0.003822	259.943
Hg	0.003678	0.025746	198.023
Mn	0.0002041	0.001487	220.352
Pb	0.004029	0.028203	196.026
V	0.001221	0.008547	292.402
Zn	0.0001288	0.0009016	213.858

2.4Statistical analysis

Statistical data concentrations were provided using (GraphPad Prism 9 statistical package, version 9.3.1 software). Descriptive statistics were analyzed to compare the number of heavy metals and kidney function parameters among oilfield workers (Exposed group) compared to persons who have never worked in this field (Control group) by performing the Student's t-test. Significance was set at $P < 0.05$, and reported values are mean ± SEM.

3.RESULTS AND DISCUSSION

Heavy metal air pollution can occur as a result of coal combustion derivatives and petro-chemical spillage, as well as high dermal absorption values (Sathyamoorthy et al., 2016). The descriptive statistics for the concentration of heavy metals like (Ag, Cd, Fe, Hg, Mn, Pb, V and Zn) in both groups are shown in Figure 2. Most heavy metal concentrations have always been 1–10-fold greater in the exposed group than in the control group, and they were always identified in the exposed group, which cause to indicate the influences of the workplace environment on the increasing concentrations of heavy metals in employees' blood. In both control and exposed groups, Fe metal was the highest value of concentration and Cd metal was found to have the lowest value. The ranges of (Ag, Cd, Fe, Hg, Mn, Pb, V and Zn) concentrations from the control group were (0.0007 ± 0.0001792, 0.00025 ± 0.0001230, 0.2837 ± 0.01983, 0.0426 ± 0.004297, 0.0411 ± 0.01276, 0.01095 ± 0.001307, 0.00165 ± 0.0002542, 0.1788 ± 0.03718) (µg/L), respectively. Whereas, from the exposed group were reported on (0.00005 ± 5.000e-005, 0.0 ± 0.0, 0.3641 ± 0.02093, 0.04935 ± 0.01425, 0.1811 ± 0.02387, 0.0130 ± 0.001183, 0.0028 ± 0.0002248, 0.1719 ± 0.01360) (µg/L), respectively (Table 1). Comparing the serum exposure group to the control group, the concentrations of (Fe, Mn, and V) rose significantly could be due to the impact of the oil-industrial zone and toxic chemical inhalation exists in the air. This study's results are consistent with those findings of Al-Rudainy (2010) (Al-Rudainy, 2010) from Basrah, Iraq, and Al-Shamri et al. 2010 (Tayrab et al., 2014) from Najaf, Iraq. There was no significant difference in the levels of Hg and Pb in the exposed group compared to the control group. Except for Zn, which decreased non-significantly, the values for Ag and Cd metals in the exposed group were significantly lower than in the control group. It may be caused by an increase in the rate of natural gas flaring during oil processing and Emissions from activity sources. Aside from the toxic effects, there are several significant and beneficial roles in human metabolism. Fe, Hg, Cd, and Zn were formed as cofactors of antioxidant enzymes and are used continuously to create antioxidant enzymes involved in the detoxification of ROS and the effect of different anthropogenic sources. The results agree with the prior study (Negi et al., 2012).

On the other hand, many industrial and chemical workers are exposed to toxic and poisonous vapors daily. As a consequence of this, they are capable of causing abnormalities in the functioning of a lot of target organs (Khan et al., 2013). The kidney is a primary target for toxicity of heavy metals because it tends to reabsorb and concentrate metals. Hence, the kind, dose, and duration of exposure all affect how severely kidney function is affected (Lentini et al., 2017). The mean value of some kidney function parameters such as (Blood urea, Creatinine and Uric acid) were compared between control and exposed groups can be seen in Table 3 and Figure 3.

In the current study, the mean value for both blood urea (30.55 ± 1.567) and Creatinine (0.8050 ± 0.04838) levels in the exposed group were non-significantly greater than the control group (26.40 ± 2.145), (0.6550 ± 0.05780), respectively. However, serum uric acid level (6.340 ± 0.2858 mg/dl) was found to be significantly higher in the exposed group compared to the control group (4.755 ± 0.3719 mg/dl) because most chemical substances are toxic to many organ systems, including the kidney exposure to some heavy metals including (Cd, Hg and Pb) were caused to hyperuricemia (Jung et al., 2019). Additionally, it has been demonstrated that combining several metals can have a cumulative nephrotoxic impact (Sabath and Robles-Osorio, 2012). Also, those with poor renal function and greater metal exposure levels lived nearer to the petrochemical industry (Yuan et al., 2021). This finding is consistent with others, which could be due to purine and pyrimidine degradation or an increase in blood Urea levels caused by either overproduction or inability to excrete (Abdel Aziz and Al Agha, 2006, Abou-ElWafa et al., 2015).

Table 2. Evaluation of various heavy metal concentrations between the control group and exposed group.

Parameter	Mean ± SEM of Control group (µg/L)	Mean ± SEM of Exposed group (µg/L)	P-value
Ag	0.0007 ± 0.0001792 N=20	0.00005 ± 5.000e^{-005} N=20	0.0012
Cd	0.00025 ± 0.0001230 N=20	0.0 ± 0.0 N=20	0.0492
Fe	0.2837 ± 0.01983 N=20	0.3641 ± 0.02093 N=20	0.0082
Hg	0.0426 ± 0.004297 N=20	0.04935 ± 0.01425 N=20	0.6528
Mn	0.0411 ± 0.01276 N=20	0.1811 ± 0.02387 N=20	< 0.0001
Pb	0.01095 ± 0.001307 N=20	0.0130 ± 0.001183 N=20	0.2521
V	0.00165 ± 0.0002542 N=20	0.0028 ± 0.0002248 N=20	0.0016
Zn	0.1788 ± 0.03718 N=20	0.1719 ± 0.01360 N=20	0.8630

Table 3. Evaluation of some kidney function parameters between the control group and exposed group.

Parameter	**Mean ± SEM of Control group (mg/dl)**	**Mean ± SEM of Exposed group (mg/dl)**	**P-Value**
Blood Urea	26.40 ± 2.145 N=20	30.55 ± 1.567 N=20	0.1265
Creatinine	0.6550 ± 0.05780 N=20	0.8050 ± 0.04838 N=20	0.0538
Uric acid	4.755 ± 0.3719 N=20	6.340 ± 0.2858 N=20	0.0017

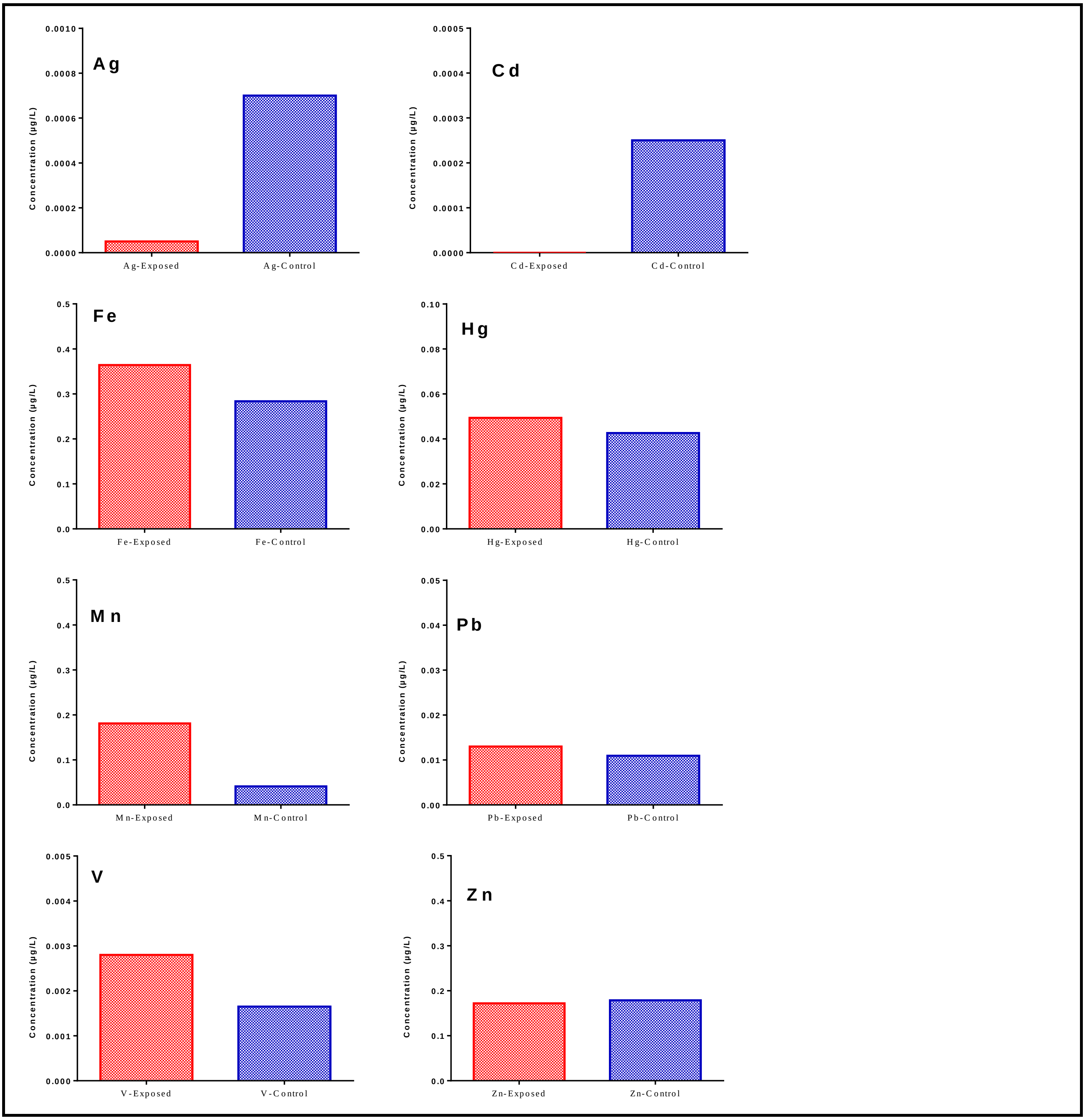

Figure 2: Bar chart plot of heavy metal concentrations between exposed and control groups.

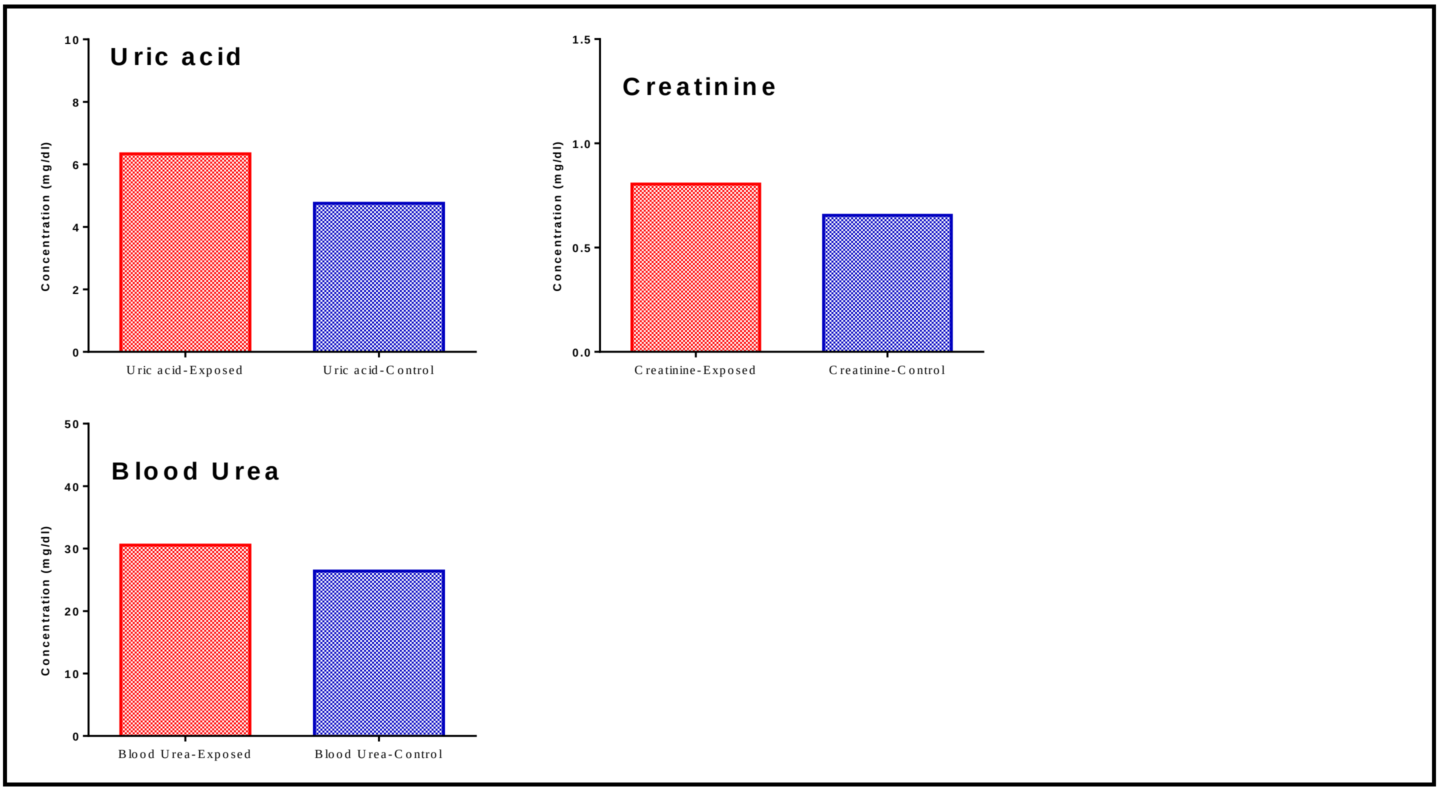

Figure 3: The concentration levels of kidney function parameters.

4.CONCLUSIONS

Overall, most of the heavy metals analyzed significantly differed between the control and exposed groups. Moreover, kidney function (uric acid) significantly raised the petroleum industry as one of the primary environmental pollution sources. Heavy metals could be due to leading damage kidney function. According to the research results, employees' daily petrochemical exposure significantly affects on some heavy metal levels and may increases the chances of getting kidney disease.

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